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EQUIPMENT

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DESIGN PARTICULARS OF SUCTION SYSTEMS IN SECTIONAL SHOPS

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Different designs of the baffles used in suction systems to decrease the unorganized dust emissions arising during the transfer of bulk material into receiving hoppers of sectional and batch-preparing shops are examined.

Key words: unorganized dust emissions, suction system, baffles, rotating slats, railroad cars.

The main sources of dust and pollution generation in the production of glass batch and different multicomponent mixtures are unorganized emissions, which usually arise because of a loss of seal of the process equipment, lack or unsatisfactory operation of suction systems at locations where raw materials are transferred from one technological unit to another as well as when materials delivered to sectional shops in big-bags or in bulk in vehicles and railroad cars are unloaded.

For example, when bulk material is unloaded from a hopper-type car into a receiving hopper, located in a pit beneath the railroad tracks, intense dust emission occurs as a result of the free fall of material from a substantial height, which depending on the depth of the pit can be 2 – 6 m, as well as because of a leak in the unloading line and the large volume of air displaced from the receiving hopper through the standard unloading grates with 80 × 80 ... 100 × 100 mm input cells.

The materials also generate dust because of draughts which arise when a chain of several cars passes through the receiving pavilion of a sectional shop.

Since modern sectional shops are essentially dispensing-mixing divisions and are short in length, the wagons in them are unloaded with the pavilion gates open, since for 6 – 10 cars in a chain no more than three cars can be present in 36 – 48 m long receiving pavilion.

For this reason the successive unloading of cars with the pavilion's gates closed though possible in principle is very rarely done used in practice because of the large volume of the maneuvering operations performed with the railroad structure and the increase in the total time required to unload the raw materials.

Facilities for unloading railroad cars (Fig. 1) containing special gratings equipped stationary and rotating slats with different design are used to decrease dust generation in the divisions receiving the raw materials and reduce the disorganization of the dust emissions formed as a result of intense displacement of air through the loading gratings of the hoppers receiving the raw materials.

Such facilities operate as follows. The dust generating material flows from the wagon hopper *1* onto the baffle *2* and

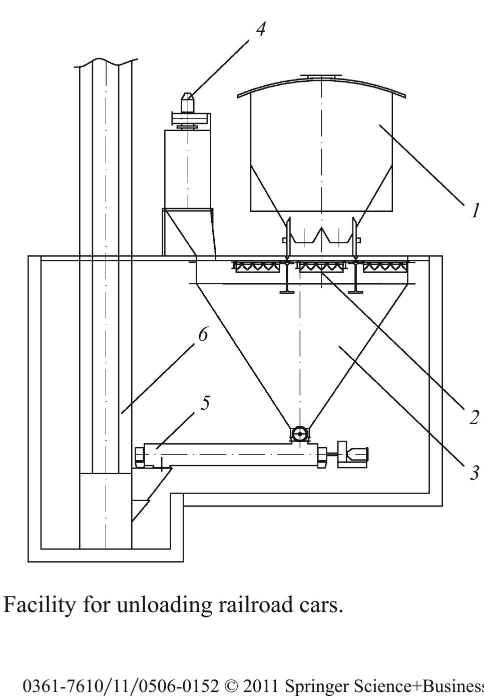

Fig. 1. Facility for unloading railroad cars.

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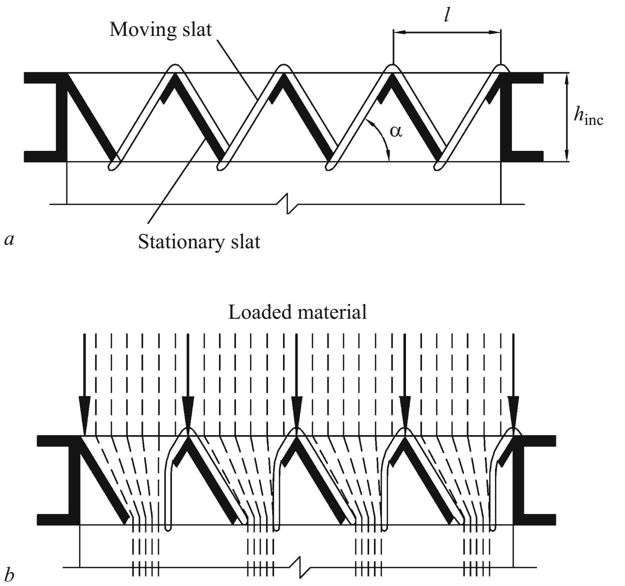

Fig. 2. Baffle with inclined rotating slats: *a*) initial state; *b*) material unloading regime.

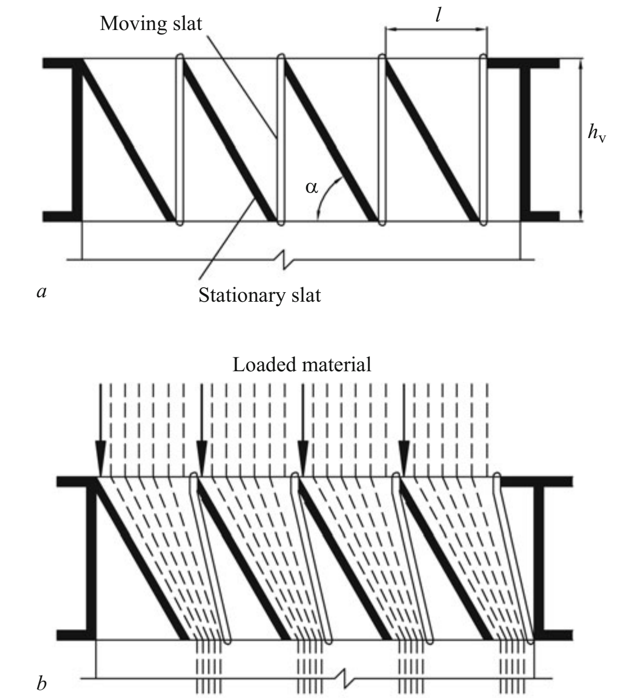

Fig. 3. Baffle with vertical rotating slats: *a*) initial state; *b*) material unloading regime.

then into the receiving hopper *3*. The number of gratings depends on the dimensions of the receiving hopper, the model of the cars unloaded, and the unloading scheme and it ranges from two to twelve. In the initial state all slats of the baffles *2* are closed (Fig. 2*a*), while the interior space of the hopper *3* (see Fig. 1) is tied to the air intake *4* facility for the filter. When the unloaded components of the glass batch strikes a baffle its moving slats, made of flexible elastic materials, are deflected from the stationary slats and the raw material flows into the interior space of the hopper (Fig. 2*b*).

A screw conveyer *5* (see Fig. 1) and an elevator *6* (other mechanisms can also be used) transport the bulk material from the receiving pavilion into a silo or a dispensing hopper in the dispensing-mixing line. Since the slats of the other baffles on which there is no unloaded material are closed, a rarefaction is created in the interior space of the hopper *3*, and the dust-laden air flows into the filter *4* of the suction system, which greatly reduces dust emissions.

The stationary and rotating slats of a baffle with this design are arranged with step l and make an angle α, which must be greater than the angle of repose of the transferred bulk material. The height h_{inc} of the baffle with inclined rotating slats is determined from the expression

$$h_{\text{inc}} = \frac{l}{2} \tan \alpha.$$

A design deficiency of baffles of this kind is that with time the elastic properties of the rotating, rubber slats weaken and do not make a tight joint with the stationary slats, so that a gap forms. When bulk materials with a small bulk mass (for example, diatomite or light soda) are unloaded, not all of the material flows through and some material sticks at the end of the car unloading cycle, which is due either to a decrease of the flexibility of the material used for the rotating slats or with their initially high rigidity. All this makes the suction system less efficient and generates additional dust.

To eliminate these deficiencies “Stromizmetritel’” JSC developed a different modification of a baffle for unloading bulk materials. In this grating, the stationary slats make an angle to the horizontal direction, the rotating slats are positioned vertically (Fig. 3) and are made of a more flexible material, which deflects easily even when light components of a glass batch pass through the grating.

The height h_{v} of such a grating with vertical rotating slats is double the height h_{inc} and is calculated from the relation

$$h_{\text{v}} = l \tan \alpha.$$

However, increasing the height of the gratings (with l = 200 – 250 mm, $\alpha = 60°$, h_{v} = 345 – 430 mm) does not limit their use for unloading bulk materials from cars into receiving hoppers, since the height of the ties below the tracks, between which the gratings are placed, is usually greater than the height of the gratings themselves.

If definite limitations due to, for example, the small dimensions of the receiving hoppers when feeding transferred material into the hopper of a skip hoist are still present, then different baffles are used — smaller height, in which each slat has a rigid balance structure. A skip hoist equipped with such a grating, developed at the “Stromizmeritel’” JSC, was placed on the section where fire clay was processed in the

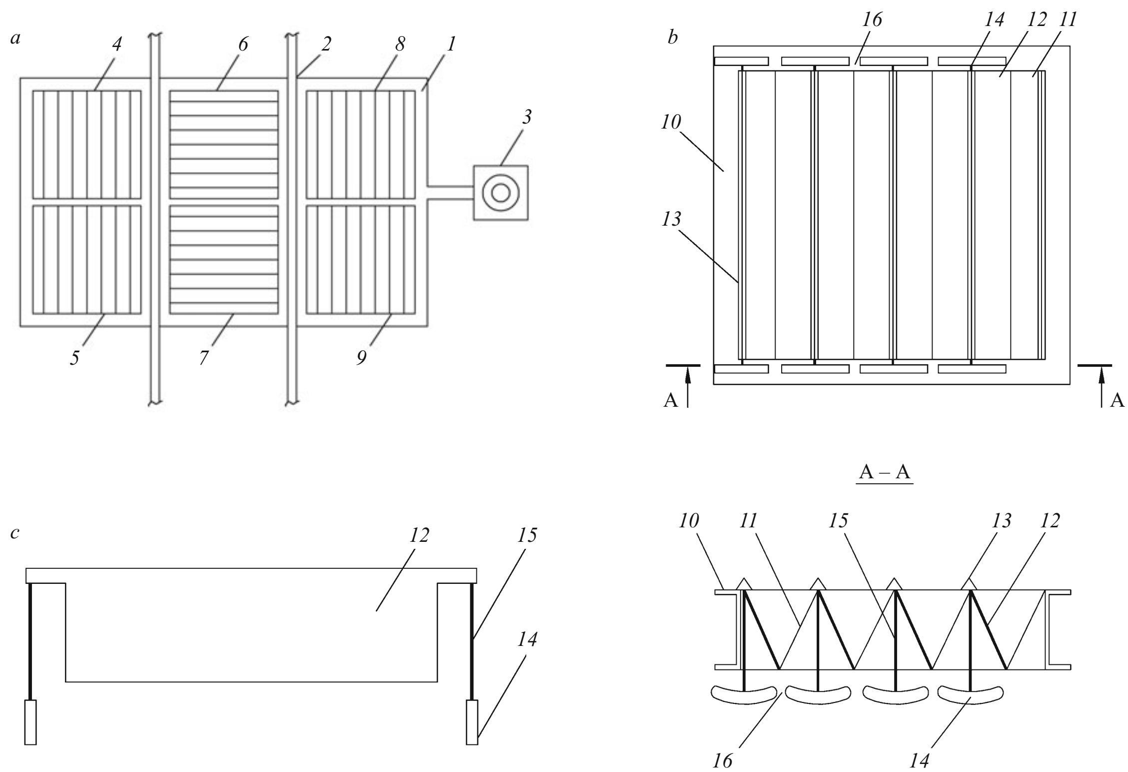

Fig. 4. Improved baffles (IB): *a*) arrangement of the IB on the receiving hopper; *b*) top view of IB; *c*) mobile slat of IB.

production of fireclay refractories at the IGC "Borskii stekol'nyi zavod" [1].

A deficiency of this apparatus is the large number of rotating slats (4 – 6 slats per row) and the fact that periodically they become wedged because the loads balancing them, though they are all closed at the top by special corners, are in the material passage zone. This observed especially often when small-piece materials are reloaded through a baffle.

In addition, just as in most baffles with different designs with complete overlapping of the slats by the material being transferred and with all other slats through which raw material does not flow being closed, external dusting generation occurs over the baffle as a result of the screening of the space above the grating and the absence of suctioning of air inside the receiving hopper, connected with the suction system.

To prevent any negative effect due to the above-lattice space being completely screened from the suction system V. V. Efremenkov proposed an improved design of the baffle (RF patent No. 94552 for a useful model), which partially solves this problem.

The improved baffles (Fig. 4) function as follows. Baffles *4 – 9* are placed on the top cover of the hopper *1* (Fig. 4*a*), placed beneath the railroad tracks *2* and tied to the suction system *3*. The support frames *10* (Fig. 4*b*) of the baffles *4*, *5* and *8*, *9* are oriented so that the stationary *11* and moving *12* slats are parallel to the railroad tracks, and the frames of the baffle gratings *6*, *7* are positioned taking account of the perpendicular arrangement of the slats relative to the railroad tracks. The direction of rotation of the slats with such an arrangement of the gratings is chosen in accordance to the direction of motion of the material during transfer — from the center to the edges of the flow. The slats *12* of the baffles *4*, *5* turn to the left from the railroad tracks *2* while the baffles *8*, *9* turn to the right. The slats *12* of the gratings *6*, *7*, arranged in the space between the rail tracks, also turn in different directions — from the center to the edges of the material flow zone.

In the initial state all moving slats *12* (Fig. 4*c*), which have a rigid structure and are protected from above by the corners *13*, which prevent deformation of the slats, are closed (see Fig. 4*b*). The interior space of the hopper *1* is in a rarefaction state when the suction system is in operation. A prescribed gap *16*, whose width is 20 – 50 mm and set during regulation, is present between the arch-shaped cam elements *14*, connected with the rotating slats *12* by means of cantilevers *15*.

When the bulk material strikes the baffle as a car is being unloaded (dump truck or skip hoist) the moving slats 12 of the baffles *6*, *7*, located at the center of the material being unloaded, open completely (Fig. 5). On the baffles *4*, *5*, and *8* the material can partially fall one or two moving slats. Material pours through the open slats *12* into the interior space of the hopper *1*, from which the suction system *3* suctions the displaced dust-laden air.

The mobile slats open at the boundary of the rarefied material, forming slit-shaped suctioning of dust along the con-

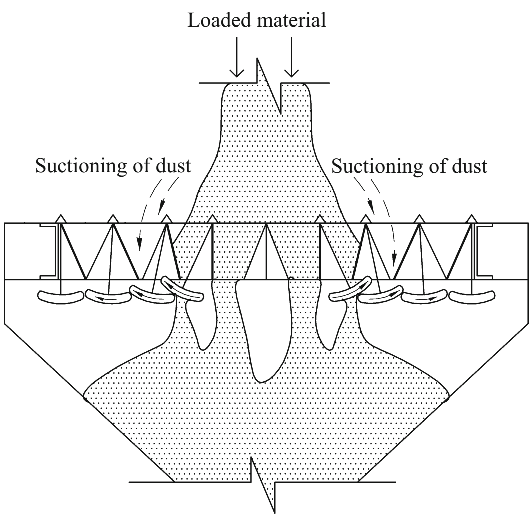

Fig. 5. Transfer of bulk material through an improved baffle.

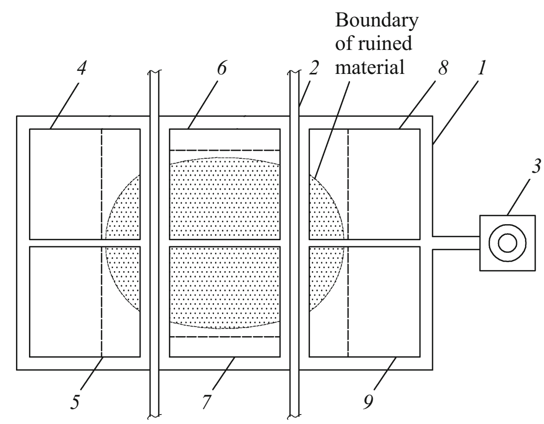

Fig. 6. Formation of slit suction in the zone of material transfer through the improved baffle grating: *1 – 9*) correspond to the notation presented in Fig. 4; **. . . .**) zone of slit suction.

tour of the unloading boundary (Fig. 6). The width of the slit suction is 5 – 10 mm and is determined by the geometric dimensions of the cam elements which interact with one another. The slit suction is formed as follows. When a mobile slat *12* turns (see Fig. 4) during the passage of material the cam element *14* corresponding to it, secured by the cantilever *15* to the rotating gate at the support point of its rotation, also turns, choosing the gap between the neighboring cam elements along the path.

If a slat opens by an amount smaller than this gap, i.e., a small amount of material passes through it, then the cam elements do not interact with one another and the neighboring moving slat, which no material passes, remains closed. In this case there is no need for slit suction to form, since effective suctioning of air with dust from the grating space into the interior volume of the hopper, which is in a rarefaction state, occurs when a small amount of material passes through the moving slat.

However, if the deflection of the moving slat is large, i.e., a large amount of material passes through it, and it screens the exterior space from the interior rarefied space of the hopper, then slit suction must be established on the neighboring moving slat. This is accomplished by rotating the cam element of this rotating slat by an amount larger than the gap and deflection of the neighboring cam elements by a fixed amount. The fixed magnitude of the deflection of the neighboring cam elements is determined by the arch shape of the cam elements and remains unchanged during further deflection of the rotating slat after passage and choosing the gap between the cams.

The opening mobile slat forming slit suction turns by an angle such that the corresponding cam elements shifts by only 5 – 10 mm, so that the next rotating slat, being located behind the open slat, does not open.

Once the transfer of bulk material is completed the cam elements rotate into the initial state of stable equilibrium, since the center of gravity of the balances loads lies below their rotation support point. The rotating slats return to the initial closed state and adjoin the stationary inclined slats. The excess dust-laden air is suctioned off by the suction system. After the dust-laden air is filtered the dust and small particles of the transferred material return to the regeneration regime inside the hopper.

In summary, the development and adoption of different baffles and different suction equipment which decreases the unorganized emission of pollutants during unloading of the raw materials make it possible to optimize the suction system and substantially improve the working conditions for service workers and the sanitary state of the sectional and mass-fabrication shops.

REFERENCES

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